B.E. (SEM-VII) CBSGS

MECHANICAL

COMPUTATIONAL FLUID DYNAMICS.

Q.P. Code : 793901

(3 Hours) **[Total Marks : 80**

N.B: 1) Question No.1 is compulsory

2) Attempt any three questions of the remaining five questions

3) Assume suitable data wherever necessary

4) Figures to the right indicate maximum marks

Q.No.1 Answer any four **20**

a) What is CFD? Discuss its applications

b) Write the Navier Stokes equations and discuss the various parameters in the equation

c) Explain the initial and boundary conditions with examples

d) Give an account of the errors in CFD

e) What are the characteristics of turbulent flows?

Q.No.2 a) Discuss the significance of Reynolds Averaged Navier Stokes Equation for incompressible flows **06**

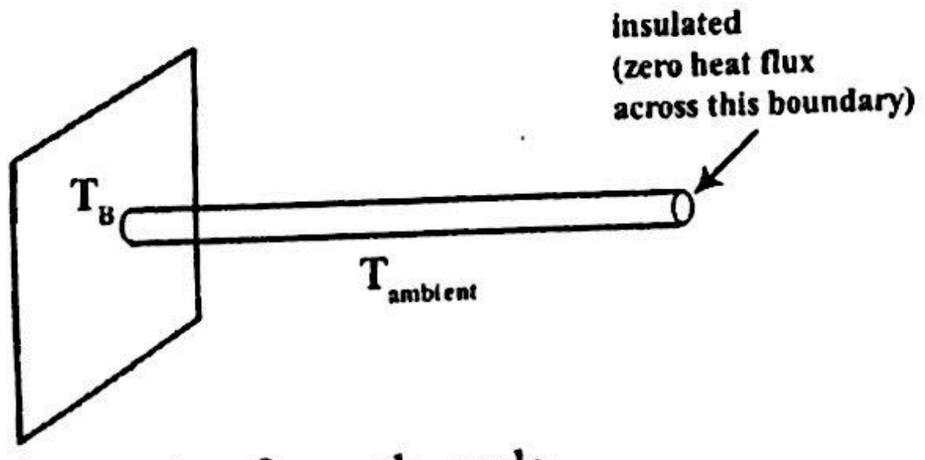
b) Explain the Mixing Length model used in Turbulence Modeling **04**

c) What is a SIMPLER algorithm used for? Explain the steps involved in the algorithm **10**

Q.No.3 Figure shown is of a cylindrical fin with uniform cross sectional area A and length L = 1.5 m. The base is at a temperature of 100 ^{0}C and the end is insulated. The fin is exposed to an ambient temperature of 20 ^{0}C. One dimensional heat transfer equation for the above phenomenon is **20**

$$\frac{d}{dx}\left(k\,A\frac{dT}{dx}\right) - hP(T - T\infty) = 0$$

where h is the heat transfer coefficient, P is the perimeter, k is the thermal conductivity of the fin material and T_∞ is the ambient temperature. Take $\frac{hP}{kA} = 30/m^2$



- Obtain the discretized equation for each node
- Arrange the equations in the matrix form and solve it to find the steady state temperature at five equally spaced nodes using TDMA

TURN OVER

Q.No.4 a) A property ϕ is transported by means of convection and diffusion through a one dimensional domain. The governing equation to be used is

$$\frac{d}{dx}(\rho u \phi) = \frac{d}{dx}\left(\Gamma \frac{d\phi}{dx}\right).$$

The boundary conditions to be used are at $x = 0$, $\phi_0 = 1$ and at $x = L$, $\phi_L = 0$. Assume that the property is transported from $x = 0$ to $x = L$. Using five equally spaced nodes and a Central Differencing scheme, calculate the distribution of ϕ as a function of x for $u = 0.2$ m/s, $L = 2$ m, $\rho = 1.1$ kg/m^3, $\Gamma = 0.1$ kg/ms

b) What is a grid? What are the parameters used to define grid quality

Q.No.5 a) An insulated rod of cross-sectional area 20×10^{-3} m^2 is maintained at temperatures of 120^0 C and 480^0 C at its two ends. A uniform source of 1200 KW/ m^3 is supplied to it . The thermal conductivity of the material of the rod is 1400 W/m/^{0}C. The length of the rod is 300 mm. Assuming steady conditions and one dimensional heat conduction, calculate the temperature at 5 equally spaced nodes (other than the boundary nodes). Do a finite volume discretisation and perform the following steps

- Write the governing equation
- Discretize the equations
- Write the equations in matrix form
- Solve the matrix

b) What are the differences between FDM and FVM

Q.No.6 Answer the following

a) Name the properties of discretization schemes and discuss them

b) What are upwinding schemes? Explain the QUICK scheme

c) What is a staggered grid? Where and why is it used?
